

## DOCUMENT RESUME

ED 130 660

95

IR 004 202

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TITLE Work Identification as a Function of Semantic Clues  
and Association Strength. Analysis of Meaning with  
Restricted Association Tests, Report Number 12.  
INSTITUTION Michigan Univ., Ann Arbor. Dept. of Psychology.  
SPONS AGENCY National Inst. of Mental Health (DHEW), Bethesda,  
Md.  
PUB DATE 20 Dec 66  
GRANT NIH-MH-07619  
NOTE 23p.; Archival document

EDRS PRICE MF-\$0.83 HC-\$1.67 Plus Postage.  
DESCRIPTORS \*Associative Learning; College Students; \*Cues;  
Educational Research; Higher Education; Semantics

## ABSTRACT

To examine the relationship between words that pinpoint or help to define other words, an experiment was designed which reversed the procedure used in collecting the Michigan Restricted Associated Norms. The Michigan procedure used stimulus words to elicit responses. These responses were used as clue words to determine their power to stimulate the target words. Some 36 university students were randomly assigned to one of three experimental groups. Subjects in two groups were given either all infralogical or all logical clues, and the third group received mixed clues. Clue words were selected in six different categories of associations: (1) superordinate, (2) subordinate, (3) similar, (4) location, (5) part, and (6) preceding. Results showed the power of clue words varied according to association strength, number of clues, type of clue, size of respondent set, and reaction time. This report describes in detail experimental procedures and provides a summary of results. (EMH)

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Word Identification as a Function of Semantic Clues  
and Association Strength

by

Marilyn T. Zivian

Analysis of Meaning with Restricted Association Tests  
Report Number 12

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20 December 1966

Supported by the National Institute of Mental Health

Grant Number MH 07619

Principle Investigator: Klaus F. Riegel

Word Identification as a Function of Semantic Clues  
and Association Strength

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What is a good procedure for defining a word by means of other words? Which relations linking other words to the word whose meaning you wish to convey are the most efficient for pinpointing that word? The present experiment attempts to answer these questions by reversing the experimental procedure used in collecting the Michigan Restricted Association Norms (Riegel, 1965). Responses originally given to stimuli of the Norms are used here as clues to discover under what conditions Ss will respond with the original stimuli.

To avoid confusion, several terms shall now be defined. The stimuli and responses of the Michigan Restricted Association Norms shall be referred to as the original stimuli and original responses respectively. In the present experiment a clue word is one of the original responses and a S's response to that clue is scored correct if it is the target word, namely the original stimuli. For instance, if the original stimulus were the word FOOT, and if the original response to the task Parts were TOE, then the clue would be of the form: Part...TOE. The correct response, or target word, would be FOOT. From this example it can be seen that in addition to the original response, each clue also contains the type of restricted association between the target word and the clue word.

The target word may be elicited correctly by one, or several, of five factors: First, there is the degree of free association strength between the original response and the original stimulus. The greater the degree of free association strength, the more frequently Ss should respond correctly.

Second, each clue may be appropriate for sets of words which include more than just the target word. The larger these sets are, the less likely it is that S will respond correctly.

Third, in the present experiment clue words with high restricted association strength (as determined by the Norms) are tested against clues with low restricted association strength. If restricted associations are reversible, then the stronger the restricted association is between the original stimulus and the original response, the more easily the clue word should elicit the target word.

Fourth, combinations of several original responses are given as clues. Increasing the number of clues decreases the size of the set from which S can choose a word and still have his choice fit all the clues. This reduction in the size of the set of possible responses should augment the probability that Ss will find the target word. Thus, increasing the number of clues should increase the frequency of correct responses.

Fifth, the types of restricted associations which are used as clues in the present experiment can be partitioned into two sets. One set consists of original responses which imply a temporal or spatial relation to the original stimulus. The other consists of original responses which are related to the original stimulus by class membership and class relations. These two sets will be called infralogical and logical clues respectively (Flavell, 1963). Both types of relations should be equally well formulated by adulthood (Inhelder and Piaget, 1964) and thus, it is expected that each will be equally effective in eliciting target words.

#### Methods and Procedures

Subjects: Thirty-six students at the University of Michigan were randomly assigned to one of three experimental groups so that there were six males and six females in each group. Ss in two experimental groups were given either all infralogical or all logical clues. Ss in the third experimental group received mixed clues.

Types of Clues: Ss were told that they would be shown 180 cards containing one, two, or three clues to target words which they were to guess. They were instructed to respond once to each card and that all target words were nouns. Ss were told that they would be timed, but that it was more important to find an appropriate response than to answer quickly.

Six of the sixteen restricted association tasks of the Norms were used for the selection of clues. Superordinate, Subordinate, and Similar responses made up the

set of logical clues. The infralogical clues were chosen from Parts, Locations, and Precedings. The clues were explained to Ss using almost the same wording and the same examples applied in collecting the Norms.

- Superordinate:** You will be given a class-name for the word to be predicted. For instance, the clue may be: Superordinate... SILVERWARE. In this case the word to be predicted could be FORK.
- Subordinate:** You will be given a word of that class which is denoted by the word to be predicted. For instance, the clue may be: Subordinate...RAKE and in this case the word to be predicted could also be FORK.
- Similar:** You will be given a word that means essentially the same as the word to be predicted. For instance, the clue may be: Similar...AUTO and this time the word to be predicted might be CAR.
- Location:** You will be given a location of the thing to be named. For instance, the clue might be: Location...GARAGE and the word to be predicted CAR.
- Part:** You will be given the name of an essential part or attribute of the thing to be named. For instance, the clue might be: Part...EXPERIENCE and the word to be predicted WISDOM.
- Preceding:** You will be given the name of something that frequently occurs prior to the thing to be named. For example, the clue might be: Preceding...FIRE and the word to be predicted could be ASHES.

**Restricted Association Strength:** Each clue word is related to a target word at either high or low restricted association strength. Clue words with high restricted association strength were selected so that for each of the six types of clues used in connection with any target word the strength of relationship was as equal as possible. These clue words were also chosen so that there would be the least possible overlap with the other infralogical and logical tasks on the Norms. For instance, if for the target word FORK, the Superordinate clue of UTENSIL were selected, and if this clue had a restricted association strength of 50, then the restricted association of all other high restricted association strength clues used in connection with the word FORK would have a restricted association strength of about 50. Furthermore, UTENSIL was selected as a Superordinate clue only if it did not appear as a frequent response to any of the other five restricted association tasks. The mean strength of the high restricted associations for the six types of clues ranged from 28 to 44. Clues with low restricted association strength were selected from those original responses which were given exactly three times to the original stimulus under the appropriate task. They were also chosen so as to minimize overlap with other tasks.

**Target Words:** Thirty-six of the original stimuli were selected to be the target words. They were all nouns and were those original stimuli the responses to which best fit the above restrictions. Control for the effects of the word frequency of the target words was imposed by applying each target word under every condition to be tested in the present experiment.

Combinations of Clues: Since clue combinations composed of all logical clues or all infralogical clues were determined in precisely the same manner, only the procedure for constructing combinations of logical clues will be given.

First, a particular two-way combination was assigned to every target word with the restriction that no double clue consist of single clues having the same relation to the target word. For example, a Superordinate clue of high restricted association strength could not be combined with a Superordinate clue of low restricted association strength to form a double clue for a particular target word. Thus, a Superordinate clue of high restricted association strength was combined only with Subordinate clues of high or low restricted association strength or with Similar clues of high or low restricted association strength. These combinations yield four double clues. The same combinations can be made using a Superordinate clue of low restricted association, yielding four additional double clues. The only possible two-way combinations left are the four double clues made by combining a Subordinate clue of high restricted association strength with a Similar clue of high or low restricted association strength and by combining a Subordinate clue of low restricted association strength with a Similar clue of high or low restricted association strength. Thus, this procedure yields twelve two-way logical combinations. Each of these combinations was repeated three times to make a set of 36 double logical clues, one for each target word.

To form the single clues, each double clue was split, yielding 72 single clues, 36 clues with high restricted association strength and 36 with low restricted association strength. Each target word was associated with two different single clues and there were twelve replications of each of the six possible types of relation. For example, there were twelve Superordinate clues of high restricted association strength and they came from the three replications of the four possible two-way combinations which contained a Superordinate clue of high restricted association strength.

Triple clues were formed by adding first the high, and then the low, restricted association clues of the remaining task to the double clue. For instance, if a two-way combination consists of a Superordinate clue with high restricted association strength, and a Similar clue with low restricted association strength, then one triple clue would consist of Superordinate and Subordinate clues of high restricted association strength and a Similar clue of low restricted association strength. The other triple clue would consist of a Superordinate clue of high restricted association strength and Subordinate and Similar clues of low restricted association strength. This procedure yields 72 triple logical clues, two for each target word, and nine replications of each type of three-way logical combination.

Thus the final test administered to one experimental group consisted of 180 logical clues: 72 single clues, 36 double clues, and 72 triple clues. The test given to the second experimental group consisted of 180 infralogical clues partitioned among the combinations in the same manner.

So in the third experimental group also received 180 clues, 36 mixed double clues and 144 mixed triple clues. Since a mixed clue must contain at least one logical and one infralogical clue, single clues are not possible. This restriction also reduced the total number of two-way combinations which could be obtained from the twelve types of relations (six logical and six infralogical) to 36. One mixed double clue was thus assigned to each target word. The double clue was further restricted in that it had to be a mixed combination which included two of the four single logical and infralogical clues already associated with that target word. The mixed triple clues were formed by adding a high or low restricted association clue from each of the remaining four relations. These were distributed so that exactly two clues with high and two clues

with low restricted association strength were added to each mixed two-way combination. This yielded 144 triple clues with no replications. Each target word had exactly four mixed triple clues associated with it.

Presentation: Clues were displayed to the Ss on unlined 3" x 5" cards. Each card contained either one, two, or three clues and each clue consisted of the clue word and the name of the relationship of that word to the target word. The position in which each type of relation appeared on the card (top, middle, bottom) was randomized within each two-way and three-way combination.

There are six possible orders in which the series of single, double, and triple clues can be presented. Each order was presented to two of the twelve Ss in the groups receiving either all logical or all infralogical clue combinations. Six Ss in the group receiving mixed clue combinations received the double clues first and six Ss received the triple clues first. Within each series (single, double, or triple) the clues were randomized and administered to each S in the same random order.

All Ss were tested individually. E recorded their responses and the time which elapsed between the presentation of the clues and the responses. Ss were not told whether their responses were correct or incorrect.

#### Results and Discussion

Restricted Association Strength: The percentages of target words elicited by Ss when presented with clues of differing restricted association strength are given in Table 1. As can be seen, more correct responses are given to clues with high restricted association strength than to clues with low restricted association strength, and, every replacement of a high by a low restricted association strength clue in the clue combinations served to reduce the frequency of correct responses.

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Insert Table 1 about here

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All significance tests were done by comparing the frequencies of correct identification of the same target word under the different conditions of restricted association strength disregarding the types of clues. Significantly more correct responses were given to single-high than to single-low restricted association clues ( $p < .025$ ).

Between the double clues only one significant difference was found. Double clues with one high and one low restricted association strength clue elicited the target words significantly more often than clues with two low restricted association strength clues ( $p < .025$ ).

Significantly more target words were given to triple clues containing all high restricted association strength clues than to triple clues containing two ( $p < .025$ ) or three low restricted association strength clues ( $p < .10$ ). Triple clues containing one low restricted association strength clue also elicited target words significantly more often than those containing two ( $p < .05$ ) or three low restricted association strength clues ( $p < .05$ ). And, Ss responded correctly significantly more often to triple clues with two than with three low restricted association strength clues ( $p < .05$ ). The only non-significant difference among the triple clues is between those clues containing three or two high restricted association strength clues respectively.

Thus, Ss responded with the target word consistently more often when the restricted association between the original stimulus and the original response was strong. In general, this indicates that, to some extent, restricted associations are reversible; the ability to predict that a given stimulus will elicit a particular restricted response is correlated with the ability to predict that a given restricted response will elicit a particular stimulus.

Number of Clues: In the last column of Table 2 the percentages are given at which Ss responded with the target words to single, double, and triple clues. Differences were compared by t-tests again, using the target words as their own controls. In all cases the addition of a clue significantly increased the number of correct responses. Ss responded with the target words significantly more often when they were given two clues rather than one clue ( $p < .005$ ), three clues rather than two clues ( $p < .001$ ), and three clues rather than one clue ( $p < .001$ ).

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Insert Table 2 about here

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The order of presentation of the series did not dominate the effect of the clue combinations. Target words were given more frequently to the larger clue combinations no matter when the Ss received the different series of clue combinations. However, Ss

who received multiple clues early in the experiment showed a relative increase in the percentages with which they gave target words to smaller clue combinations.

Thus, increasing the number of clues does indeed reduce the set of appropriate words from which a S chooses his answer and increases the probability that he will respond with the target word even without feedback. Merely receiving multiple clues early in the experiment was sufficient to reduce S's response set so that he responded correctly more often to smaller clue combinations than did a S who received the clue combinations in a reverse order. The importance of reducing the size of the set of appropriate responses will again be seen when the effects of specific restricted relations are discussed.

Type of Clue: Table 2 also contains the percentages at which Ss responded correctly to infralogical, logical, and mixed clues. Target words were given significantly more often to logical ( $p < .01$ ) and mixed clues ( $p < .001$ ) than to infralogical clues. The difference between the number of target words given to mixed and logical clues was not significant.

In Table 3 are given the percentage of times Ss responded with target words to each clue combination. The entries have not been averaged across any variable.

The most effective single clues in eliciting correct responses were Similar clues of high restricted association strength and the least effective were Location clues of low restricted association strength. The best double clues were Location clues of high restricted association strength combined with either Superordinate or Similar clues of high restricted association strength and Superordinate clues of low restricted association strength combined with Part clues of either high or low restricted association strength. It is difficult to discuss the relative effectiveness of the triple clues as they are not really comparable to one another; the target words were not necessarily the same and the number of observations upon which the percentages are based were not equal for each triple combination.

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Insert Table 3 about here

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In Table 4 the percentages of correct responses for each type of clue combination have been combined to demonstrate the effectiveness of the six specific relations involved. The first three rows show the percentages of target words given when each particular type of clue was the only clue, one of two clues, and one of three clues. These percentages are comparable; the number of observations are equal and the target words are the same for each entry. All three logical relations of Superordinates, Subordinates, and Similar are better clues for the identification of the target word than the two infralogical relations of Locations and Precedings. The infralogical relation of Parts, however, is a better single clue than the single logical clues of Superordinates or Subordinates. But, when clues were added to these two logical relations, more target words were given than when clues were added to the Parts relation.

In summary, Similar were found to be the best single clue. The percentages of target words given increased but slightly when second and/or third clues were added. Subordinates and Superordinates were less useful as single clues but were equally effective as Similar when used in pairs or triplets. The best double clues were found to be the classical combination of the class-name of the object, Superordinate clue, with a physical attribute of the object, Part clue. Also, the mixed clues of Locations combined with Superordinates or Similar were quite effective provided all members of the combination were related to the target word with high restricted association strength. Generally, the logical clues were more effective than the infralogical clues. Only the Part clue, when used singly, compared well with the Superordinates and Subordinates. Being the best single infralogical clue, the Part clue showed but little improvement when second and/or third clues were added. All infralogical pairs and triplets, respectively, were about equally effective even though inferior when compared with the logical combinations.

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Insert Table 4 about here

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Free Association Strength and Size of Response Set: The fourth row of Table 4 contains the free association strength between the single clue and the target word. These figures were obtained from four sets of free association norms (Bousfield, Cohen, Whitmarsh, and Kincaid, 1961; Palermo and Jenkins, 1964; Riegel, 1965; and Gerow and Pollio, 1965). They represent the average percentages at which the target words were given as free associates to the clue words. Unfortunately, only 74 of the 144 clue words used in the present experiment were listed as stimuli in the free association norms. The mean free association strengths shown are, therefore, only for these 74 clue words. A product moment correlation between the free association strength and the number of times Ss responded correctly in the present experiment to the clue words was highly significant ( $r = 0.84$ ;  $p < .0005$ ).

Aside from free association strength, the size of the set of words to which a clue word and the relation given are appropriate could be responsible for eliciting target words. Using the stimuli of the Michigan Restricted Association Norms as a representative sample of the words in the English language, the size of the sets of words for each clue was obtained by counting the number of additional stimuli to which that clue word was given as a response under the same task instructions. For instance, if the clue was Superordinate...HUMAN and the target word was ADULT, the number of other stimuli in the Michigan Restricted Association Norms to which HUMAN was given as a Superordinate was counted. The mean sizes of these sets for each relation are given in the last row of Table 4. A significant negative correlation was obtained ( $r = -0.37$ ;  $p < .005$ ). Partialling out the effect of free association strength the correlation was reduced ( $r = -0.27$ ) but was still significant ( $p < .01$ ).

It should be noted that the obtained correlations are only for single clues. No correlations were obtained between free association strength or size of response set and the percentages of target words given to multiple clues. Such computations were not performed because, first of all, there was the question of how one should combine the various values of free association strengths. Is the strength of free association between one clue word and the target word independent of the free association strength between another clue word and that same target word, especially when the two clue

words are presented simultaneously? And, secondly, the sizes of the response sets (as determined by the Norms) are reduced so greatly that there no longer is an appropriate range of scores upon which to base a correlation.

No consistent relationship could be found between the restricted association strength of a clue and either the free association strength or the size of the set of appropriate responses. Of the 74 clues which were used as stimuli in free association norms, very few were of low restricted association strength. And, there was no difference in the size of the set of appropriate responses for clues with high or with low restricted association strength.

Reaction Times: In general, target words were given significantly faster than other responses ( $p < .0005$ ). Tables 5 and 6 show the mean reaction times of target words when given to different types of clues, different clue combinations, and to clues of various combined restricted association strengths. Regardless of the association strength or type of clue involved, the reaction times of correct responses increased with an increase in the number of clues. The mean reaction time for correct responses to logical clues was greater than for mixed clues which, in turn, was greater than for infralogical clues. As can be seen in Table 6, there is no consistent trend between reaction time and the elicitation of target words under the various combinations of high and low restricted association strength. /

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Insert Tables 5 and 6 about here

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### Conclusions

The method used in the present experiment may be viewed as a word searching task. Subjects were faced with the problem of locating or "hitting upon" a word in their vocabulary which fit the restrictions of the clue or clues given to them. By use of this method the present experiment tried to imitate any situation in which linguistic information is passed on or exchanged between communicating individuals. For instance, if the meaning of a word is explained to a child, the teacher may rely on words (clue words) semantically related to the word to be explained (target word). In order to

explain what a ZEBRA is, the informer may point out that it is an ANIMAL (Superordinate), has STRIPES (Part), and is like a HORSE (Similar). The informed will then substitute the name ZEBRA for the intersect of the three semantic sets activated by the informer.

The success with which the informed will acquire a sufficiently distinct notion of a ZEBRA will depend in part on the informer's semantic strategy and, in part on the size and complexity of the informed's own verbal repertoire. The present experiment was concerned only with the former. It was assumed that the informed's verbal repertoire already included the target words, the clue words, and sufficiently clear conceptions of the semantic sets brought into focus by the informer.

In particular, the effects of five strategies or conditions were examined in the present experiment: (1) restricted association strength between the target word and clue word, (2) the free association strength between the clue word and the target word, (3) the size of the set of possible target words for a given clue, (4) the number of clues for a given target word, and (5) logical as opposed to infralogical clues. It was found that for restricted associations, the relationship between words holds in both a forward (from the clue word to the target word) and a backward direction (from the target word to the clue word) and that the strength of the relationship in the backward direction is indicative of the strength of the relationship in the forward direction. The frequency of restricted associations (strength in the backward direction) was used successfully to predict the frequency with which Ss would respond with target words (strength in the forward direction). The higher the strength of restricted association, the more often target words were given as responses.

In addition to restricted association strength, each clue also implies a degree of free associative connection between the clue word and the target word. A highly significant positive correlation was found between free association strength (in the forward direction) and the frequency with which Ss responded with target words. The frequency of "hits" was also positively related to the amount of restriction imposed by the clue. The greater the effect of the restriction, i.e., the smaller the set of possible responses for a given clue, the more often Ss responded with the target words.

These two factors, size of the set of possible target words and the free association strength between the clue word and target word is intimately connected to the effectiveness of different types of clues. Even though infralogical and logical relations are equally well formulated by adulthood (Inhelder and Piaget, 1958), logical relations are translated more efficiently than infralogical (physical) relations. Sets of words delineated by logical relations are better defined; these sets are smaller and the words in the sets are closely interrelated as reflected in free association norms. However, it should be kept in mind that these results and the conclusions that follow from them are a function of the specific relations investigated in the present experiment. Other types of infralogical and logical relations could yield different results.

Reducing the size of the set of possible target words is probably the prime factor which accounts for the result that adding clues invariably increases the number of "hits". Increasing the number of clues always led to an increase in the frequency with which Ss responded with the target words. This effect was found even when Ss were given multiple clues before single clues. However, those Ss who received multiple clues earlier gave more target word responses to single clues than did Ss who received the multiple clues later in the experiment. Even though Ss were never told whether they were correct or incorrect multiple clues seem to have the effect of generally reducing the size of the set of possible responses and thereby increasing the overall probability of responding thereafter with a target word.

Upon examining the reaction times of Ss when responding correctly, it would seem that the results that reaction times were longer for multiple clues and logical clues are inconsistent with the conclusions derived above concerning the size of the set of appropriate responses. One would expect that when the set of possible target words is reduced Ss will respond more quickly. However, when the set of appropriate responses is quite large almost any word will do. Responses will be emitted quickly. They will also be of high free association strength. If the search for an appropriate set of words is made more complex by adding more clues or by specifying a more strictly defined relationship then reaction time will be lengthened.

Whether a strategy shown to be efficient by the present experiment (when the informed already knows the target word), will also be good when the target word is not a member of the informed's verbal repertoire is a question which must be solved by further exploration. Similarly, it is not at all certain that strategies which work for nouns will also work for other form classes. The effectiveness of any strategy is probably also dependent upon the language in which the communication is taking place. Thus, there is a wide field of research to be explored, research of interest not only to psychologists and teachers of first and second languages, but to educators in general, and to communication scientists as well.

## Summary

Efficient ways for pinpointing a particular target word were investigated by inverting the experimental procedure used in collecting the Michigan Restricted Association Norms and determining under what conditions the responses of the norms will elicit the stimuli which originally elicited those particular responses. The three main variables which were manipulated were type of restricted relation, number of clues given, and restricted association strength. Two other variables investigated in conjunction with these three were free association strength and the size of the set of responses appropriate for a given clue. In general, Ss answered more frequently with target words to clues with higher restricted association strength, to greater numbers of clues, and to logical clues as opposed to infralogical clues. In addition, the greater the free association strength between the clue word and the target word and the smaller the size of the set of appropriate responses, the more often Ss responded correctly with the target word.

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Table 1

Percentages of Correct Responses as a Function  
of the Number and the Restricted Association  
Strength of the Clues Combined.

| <u>Association Strength</u> | <u>Singles</u> | <u>Doubles</u> | <u>Triples</u> |
|-----------------------------|----------------|----------------|----------------|
| All High                    | 23.0           | 46.6           | 59.3           |
| One Low                     | 15.9           | 32.2           | 44.4           |
| Two Low                     |                | 31.2           | 42.6           |
| Three Low                   |                |                | 36.1           |

NOTE: The entries are the percentages of all the target words given by the Ss under the various conditions, whereas significance tests were done for only the subset of target words which were correct under both of the specific conditions in question.

Table 2

Percentages of Correct Responses  
to Different Types of Clues and Clue Combinations

|         | Infralogical | Logical | Mixed | Average |
|---------|--------------|---------|-------|---------|
| Singles | 14.5         | 24.4    | ----  | 19.4    |
| Doubles | 24.8         | 42.1    | 39.8  | 35.6    |
| Triples | 32.5         | 47.6    | 48.3  | 44.2    |

Table 3

Percentages of Correct Responses to each Type of Clue Combination

| Singles |                             | Superordinate |       | Subordinate |      | Similar |      | Part  |      | Location |       | Preceding |       |
|---------|-----------------------------|---------------|-------|-------------|------|---------|------|-------|------|----------|-------|-----------|-------|
|         |                             | High          | Low   | High        | Low  | High    | Low  | High  | Low  | High     | Low   | High      | Low   |
| Doubles | Subordinate High            | 16.0          | 15.3  | 16.7        | 26.4 | 50.0    | 22.2 | 32.6  | 16.0 | 11.8     | 2.1   | 11.1      | 13.2  |
|         | Subordinate Low             | 41.7          | 33.3  |             |      |         |      |       |      |          |       |           |       |
|         | Similar High                | 58.3          | 36.1  |             |      |         |      |       |      |          |       |           |       |
|         | Similar Low                 | 58.3          | 47.2  | 63.9        | 50.0 |         |      |       |      |          |       |           |       |
|         | Part High                   | 25.0          | 30.5  | 36.1        | 25.0 | 66.7    | 0.0  |       |      |          |       |           |       |
|         | Part Low                    | 33.3          | 91.7  | 75.0        | 58.3 | 0.0     | 25.0 |       |      |          |       |           |       |
|         | Location High               | 0.0           | 100.0 | 66.7        | 75.0 | 100.0   | 16.7 | 33.3  | 16.7 |          |       |           |       |
|         | Location Low                | 100.0         | 16.7  | 25.0        | 16.7 | 83.3    | 58.3 | 22.2  | 25.0 |          |       |           |       |
|         | Preceding High              | 0.0           | 8.3   | 0.0         | 8.3  | 0.0     | 83.3 | 33.3  | 11.1 | 36.1     | 16.7  |           |       |
|         | Preceding Low               | 41.7          | 66.7  | 16.7        | 33.3 | 0.0     | 83.3 | 30.6  | 11.1 | 36.1     | 25.0  |           |       |
| Triples | Location H. Preceding H.    | 0.0           | 16.7  | 8.3         | 8.3  | 50.0    | 83.3 | 40.7  | 25.9 |          |       |           |       |
|         | Location H. Preceding L.    | 100.0         | 75.0  | 83.3        | 50.0 | 0.0     | 8.3  | 40.7  | 25.9 |          |       |           |       |
|         | Location L. Preceding H.    | 91.7          | 16.7  | 8.3         | 66.7 | 66.7    | 83.3 | 44.4  | 35.2 |          |       |           |       |
|         | Location L. Preceding L.    | 0.0           | 41.7  | 0.0         | 33.3 | 83.3    | 75.0 | 33.3  | 28.7 |          |       |           |       |
|         | Similar H. Preceding H.     | 0.0           | 0.0   | 25.0        | 25.0 | 41.7    | 91.7 | 28.7  | 23.1 |          |       |           |       |
|         | Similar H. Preceding L.     | 0.0           | 50.0  | 50.0        | 83.3 |         |      | 91.7  | 8.3  | 0.0      | 83.3  |           |       |
|         | Similar L. Preceding H.     | 41.7          | 8.3   | 25.0        | 75.0 |         |      | 58.3  | 25.0 | 66.7     | 41.7  |           |       |
|         | Similar L. Preceding L.     | 66.7          | 91.7  | 19.7        | 50.0 |         |      | 100.0 | 58.3 | 8.3      | 75.0  |           |       |
|         | Similar H. Location H.      | 16.7          | 50.0  | 50.0        | 16.7 |         |      | 0.0   | 75.0 | 83.3     | 91.7  |           |       |
|         | Similar H. Location L.      | 83.3          | 75.0  | 83.3        | 0.0  |         |      | 83.3  | 66.7 |          |       | 0.0       | 66.7  |
|         | Similar L. Location H.      | 58.3          | 91.7  | 91.7        | 83.3 |         |      | 75.0  | 91.7 |          |       | 83.3      | 41.7  |
|         | Similar L. Location L.      | 100.0         | 8.3   | 25.0        | 41.7 |         |      | 0.0   | 8.3  |          |       | 8.3       | 83.3  |
|         | Subordinate H. Preceding H. | 50.0          | 8.3   | 16.7        | 75.0 |         |      | 100.0 | 50.0 |          |       | 75.0      | 91.7  |
|         | Subordinate H. Preceding L. | 16.7          | 50.0  |             |      | 50.0    | 91.7 | 58.3  | 8.3  | 83.3     | 0.0   |           |       |
|         | Subordinate L. Preceding H. | 33.3          | 25.0  |             |      | 25.0    | 50.0 | 33.3  | 0.0  | 8.3      | 25.0  |           |       |
|         | Subordinate L. Preceding L. | 33.3          | 75.0  |             |      | 83.3    | 50.0 | 50.0  | 58.3 | 50.0     | 33.3  |           |       |
|         | Subordinate H. Location H.  | 50.0          | 8.3   |             |      | 75.0    | 16.7 | 58.3  | 58.3 | 66.7     | 25.0  |           |       |
|         | Subordinate H. Location L.  | 91.7          | 0.0   |             |      | 83.3    | 25.0 | 91.7  | 91.7 |          |       | 83.3      | 8.3   |
|         | Subordinate L. Location H.  | 8.3           | 16.7  |             |      | 91.7    | 16.7 | 66.7  | 0.0  |          |       | 0.0       | 25.0  |
|         | Subordinate L. Location L.  | 16.7          | 66.7  |             |      | 0.0     | 41.7 | 58.3  | 8.3  |          |       | 50.0      | 66.7  |
|         | Subordinate H. Similar H.   | 16.7          | 58.3  |             |      | 83.3    | 75.0 | 41.7  | 50.0 |          |       | 33.3      | 25.0  |
|         | Subordinate H. Similar L.   | 63.9          | 46.3  |             |      |         |      | 91.7  | 58.3 | 83.3     | 91.7  | 50.0      | 25.0  |
|         | Subordinate L. Similar H.   | 39.8          | 38.9  |             |      |         |      | 16.7  | 33.3 | 25.0     | 16.7  | 91.7      | 50.0  |
|         | Subordinate L. Similar L.   | 61.1          | 55.6  |             |      |         |      | 75.0  | 0.0  | 0.0      | 83.3  | 83.3      | 75.0  |
|         | Superordinate H. Part H.    | 40.7          | 34.2  |             |      |         |      | 41.7  | 83.3 |          |       | 50.0      | 16.7  |
|         | Superordinate H. Part L.    |               |       | 33.3        | 58.3 |         |      |       |      |          | 100.0 | 16.7      | 58.3  |
|         | Superordinate L. Part H.    |               |       | 0.0         | 58.3 |         |      |       |      |          | 0.0   | 0.0       | 33.3  |
|         | Superordinate L. Part L.    |               |       | 75.0        | 66.7 |         |      |       |      |          | 91.7  | 58.3      | 33.3  |
|         |                             |               |       | 75.0        | 83.3 |         |      |       |      |          | 58.3  | 100.0     | 100.0 |

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Table 4

Percentages of Correct Responses, Mean Free  
Association Strength, and Mean Size of Sets of  
Other Appropriate Responses for Each Type of Clue

|                      | Sim  | Sub  | Sup  | Par  | Pre  | Loc  |
|----------------------|------|------|------|------|------|------|
| One Clue             | 36.1 | 21.6 | 15.6 | 24.3 | 12.2 | 7.0  |
| Two Clues            | 43.8 | 39.6 | 40.7 | 31.7 | 28.0 | 29.6 |
| Three Clues          | 48.9 | 47.9 | 46.1 | 36.4 | 36.6 | 36.7 |
| Free Assoc. Strength | 15.9 | 5.8  | 1.3  | 8.5  | 3.6  | 1.2  |
| Size of Sets         | 9.8  | 3.1  | 5.6  | 4.6  | 9.3  | 19.1 |

Table 5

Mean Reaction Time in Seconds of Correct  
Responses to Different Types of Clues and Clue Combinations

|         | Infralogical | Logical | Mixed | Average |
|---------|--------------|---------|-------|---------|
| Singles | 3.1          | 3.9     | ---   | 3.6     |
| Doubles | 3.8          | 6.1     | 5.0   | 5.1     |
| Triples | 4.9          | 8.7     | 6.1   | 6.6     |

Table 6

Mean Reaction Time in Seconds of Correct Responses as a  
Function of the Number and the Restricted Association  
Strength of the Clues Combined

| <u>Association Strength</u> | <u>Singles</u> | <u>Doubles</u> | <u>Triples</u> |
|-----------------------------|----------------|----------------|----------------|
| All High                    | 3.1            | 5.2            | 6.8            |
| One Low                     | 4.4            | 5.0            | 6.6            |
| Two Low                     |                | 5.3            | 6.5            |
| Three Low                   |                |                | 6.6            |